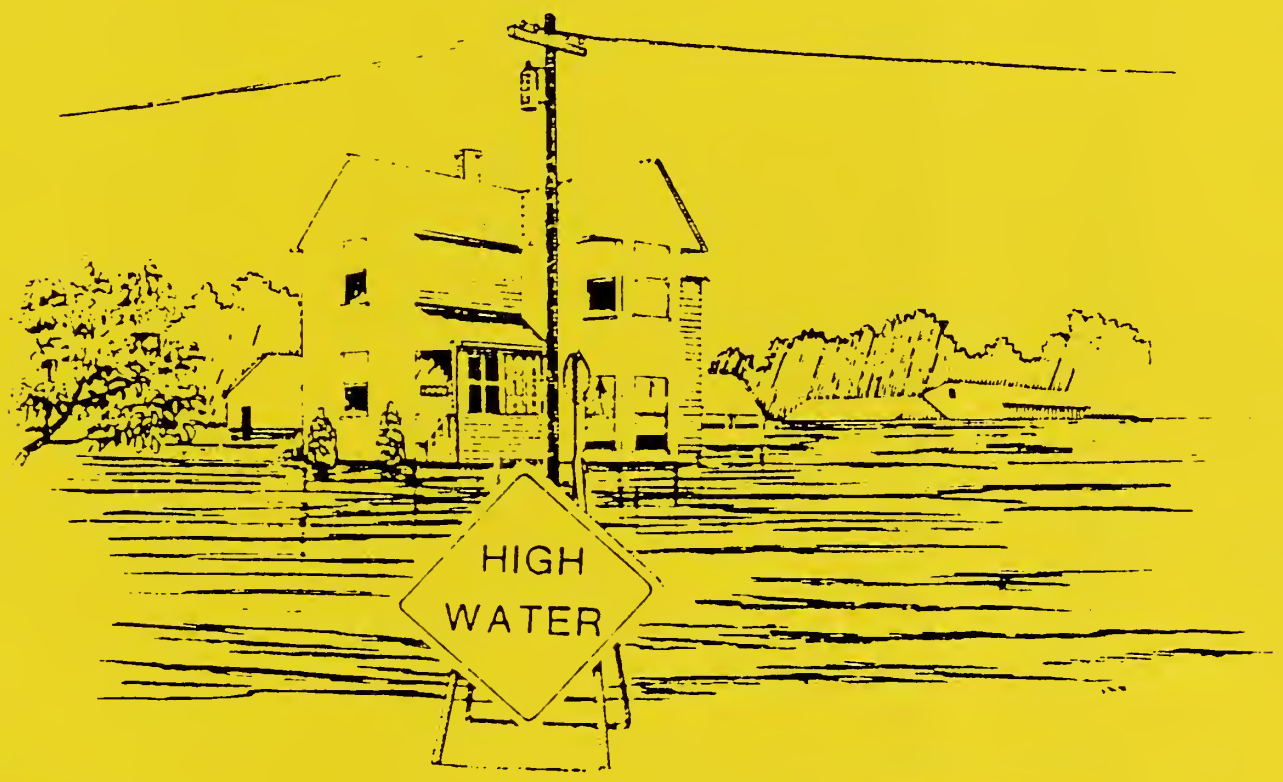
FLOOD PLAIN MANAGEMENT STUDY

OWOSSO DRAIN

SHIAWASSEE COUNTY, MICHIGAN

SEPTEMBER 1994



prepared by:

U.S. Department of Agriculture
Soil Conservation Service
East Lansing, Michigan

in cooperation with:

Michigan Department of Natural Resources
City of Owosso
Shiawassee County Drain Commissioner
Owosso Township
Shiawassee County Soil Conservation District

FOREWORD

This report defines the flood characteristics of Owosso Drain located in Owosso Township, Shiawassee County, Michigan.

This cooperative report was prepared for the guidance of local officials in planning the use and regulation of the flood plain. Four potential floods are used to represent the degree of major flooding that may occur in the future. These floods, the 10-year, 50-year, 100-year and 500-year, are defined in the report and should be given appropriate consideration in future planning for safety of development in the flood plain. Four and one-half miles of high water profiles along Owosso Drain and Bock Branch show the expected flood elevations and water depths relative to the stream bed and flood plain. The 100-year and 500-year potential floods are further defined by flood hazard area maps that show the approximate areas that would be flooded.

Flood hazard area maps and high water profiles were based on existing conditions of the basin, underground outlets, stream and valley when the report was prepared.

Information in this report does not imply any federal authority to zone or regulate the use of flood plains; this is a state and local responsibility. This report provides a suitable basis for adoption of land use controls to guide flood plain development, thereby preventing intensification of flood losses.

Technical documentation for this study is on file with the Soil Conservation Service-USDA, 1405 South Harrison Road, East Lansing, Michigan 48823 (telephone (517) 337-6701) and the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909.

Assistance and cooperation of the Shiawassee County Soil Conservation District, city of Owosso, Shiawassee County Drain Commissioner, Owosso Township and Michigan Department of Natural Resources in the preparation of this report are greatly appreciated.

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OWOSSO DRAIN

SHIAWASSEE COUNTY, MICHIGAN

INTRODUCTION

The flood plains of rivers, lakes and streams have been formed by nature to provide for the conveyance of flood flows resulting from large amounts of snowmelt and rainfall. Floods are acts of nature which cannot be wholly prevented by man. Therefore, the long-term solution to reducing flood damage and loss of life is to keep the flood plain void of development which could be damaged or which could obstruct the conveyance of flood waters. There are three basic actions which can be used to assure that flood plain areas are kept open:

1. Provide information to make lending institutions and prospective property buyers aware of the flood hazards.

2. Initiate flood plain regulations to prevent the development of the flood plain in a manner which would be hazardous during floods.

3. Acquisition of flood prone areas for use as parks, open space, wildlife habitat and other public uses.

Potential users of the flood plain should base their decisions upon the advantages and disadvantages of such a location. Knowledge of flood hazards is not widespread and, consequently, the managers, potential users and occupants cannot always accurately assess the risks. In order for flood plain management to be effective in the planning, development and use of flood plains, it is necessary to:

1. Develop appropriate technical information and interpretations for use in flood plain management.

2. Provide technical services to managers of flood plain property for community, recreational, industrial and agricultural uses.

3. Improve basic technical knowledge about flood hazards.

Two Michigan state laws provide the Michigan Department of Natural Resources the responsibility and the authority to regulate all development in the flood plain areas.

> Act 288, Public Acts of 1967, establishes minimum standards for subdividing land and for new development for residential purposes within flood plain areas. This act requires that preliminary plats be submitted to the Land and Water Management Division, Michigan Department of Natural Resources for review and determination of flood plain limits. Upon completion of review and establishment of the 100-year frequency flood plain limits, the preliminary plat may be approved and minimum building requirements specified.

Act 245, Public Acts of 1929 as amended by Act 167, Public Acts of 1968, requires that a permit be obtained from the Land and Water Management Division, Michigan Department of Natural Resources before filling or otherwise occupying the flood plain or altering any channel or watercourse in the state. The purpose of this control is to assure that the channels and the portion of the flood plain that are the floodways are not inhabited and are kept free and clear of interference or obstruction which will cause undue restriction of flood carrying capacities.

Requirements established by the Michigan Department of Natural Resources for occupation and development of flood plain areas under Acts 288 and 245 are intended to be minimum requirements only. The Michigan Department of Natural Resources urges local units of government to adopt reasonable regulations which can be used to guide and control land use and development in flood hazard areas.

The Soil Conservation Service, United States Department of Agriculture carries out flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Recommendation 9(c), "Regulations of Land Use", of House Document No. 465, 89th Congress, 2nd Session and in compliance with Executive Order 11988, dated May 24, 1977. Flood plain management studies are carried out in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management". The Soil Conservation Service and the Michigan Department of Natural Resources have agreed to carry out flood plain management studies in Michigan under provisions of the Joint Coordination Agreement. Priorities regarding location and extent of such studies in Michigan have been set in cooperation with the Michigan Department of Natural Resources.

The Shiawassee County Soil Conservation District, city of Owosso, Shiawassee County Drain Commissioner, Owosso Township and Michigan Department of Natural Resources (Sponsors) believed that a flood plain management study was needed for Owosso Drain due to the flooding problems that have already occurred. The Sponsors have determined that there is an increasing need to properly plan for the preservation and use of the flood plain. They have indicated a need to develop technical information along Owosso Drain to develop effective management programs.

The Sponsors have adopted resolutions indicating they intend to use the technical information from the flood plain management study as a basis for adopting zoning regulations, health and building codes, subdivision control regulations and such other regulations that may be needed to preserve the environmental quality of their natural resources, and to protect the health, safety, welfare and well-being of the citizens of their communities.

A request for a flood plain management study was made by the Sponsors and a plan of work, dated October 1992, was agreed to by the Sponsors, along with the Soil Conservation Service. Financial contributions for this study were made by the Sponsors and the Soil Conservation Service. The Shiawassee County Soil Conservation District will assist the other Sponsors with public information dissemination.

The Sponsors provided money and surveying assistance for this study. They also furnished assistance to the Soil Conservation Service in gathering basic data. In addition, they also provided input to identify and select appropriate flood plain management alternatives.

The Land and Water Management Division, Michigan Department of Natural Resources provided coordination services with respect to study area discharges and hydraulics. They reviewed the technical aspects of the study and concurred with study results, as applicable, to implement various state statutes and provisions of the Federal Flood Insurance Program.

Natural flood plain values were obtained by the Tri-Agency Team consisting of the Michigan Department of Natural Resources, U.S. Fish and Wildlife Service and the Soil Conservation Service in April 1994. U.S. Geological Survey quadrangle maps, 2-foot contour maps provided by the city of Owosso and field checks were used to identify and delineate flood plain areas. Topographic maps, planning commission data and communications with government officials were used to determine land use and development trends. Soils information was obtained from the published soil survey report for Shiawassee County.

Two floods are delineated, the 100-year and the 500-year frequency events. These floods have an average occurrence of once in the number of years as indicated; e.g., the 100-year flood occurs once in 100 years on the average. The 100-year flood has a 1 percent chance of being equaled or exceeded in any given year. In addition to flood prone areas and the two floods delineated on the aerial maps, the 10-year and 50-year floods are also shown on the high water profiles. The flood plain management program enacted by local action is to be based on the technical results and recommendations of this report.

The Land and Water Management Division, Michigan Department of Natural Resources and the Soil Conservation Service-USDA will, upon request, provide technical assistance to federal, state and local agencies and organizations in the interpretation and use of the information developed in this study. For assistance contact:

Shiawassee County Soil Conservation District
1900 S. Morrice Road
Owosso, Michigan 48867-8913
Telephone: (517) 723-8264

DESCRIPTION OF STUDY AREA

Watershed Area

The Owosso Drain is located in the central part of lower Michigan in the central portion of Shiawassee County. It is located in U.S. Geological Survey's State Hydrologic Unit 04080205040. Its headwaters are located in the central portion of Shiawassee County. From there, the Owosso Drain flows through the city of Owosso and outlets into the Shiawassee River.

The drainage area is approximately 4.7 square miles, with land uses of residential, urban, recreation, agriculture, forest and open space. About 11 percent of the area is in woodland, 47 percent is in cultivated crops and 13 percent is brush, weeds and grass. The remaining 29 percent consists of roads and residential and commercial areas. There are numerous culverts and crossings along the drainage system, including approximately 8,300 feet of underground conduit from South Street to the Shiawassee River. Many of these are restrictive and cause the flooding of buildings and roads. Any replacement of crossings should be evaluated to see what the effect would be on downstream flooding.

There are primarily two soil associations in the drainage area. Approximately 75 percent of the area consists of the Miami-Conover-Brookston Association. These are well drained to poorly drained, nearly level to steep, loamy soils on till plains and moraines. The remaining 25 percent of the area consists of the Carlisle-Gilford-Tawas Association. These are very poorly drained and poorly drained, nearly level, mucky and loamy soils on outwash plains and in glacial drainageways.

In winter, the average daily maximum temperature is 35^{o}F, and the average daily minimum temperature is 20^{o}F. In summer, the average daily maximum temperature is 68.7^{o}F, and the average daily minimum temperature is 46.6^{o}F.

The average annual temperature is 47.8^{o}F. The average annual precipitation is 29.58 inches. Of this, 18.93 inches, or 64 percent, usually falls in April through September, which includes the growing season for most crops. The average annual snowfall is 40.5 inches.

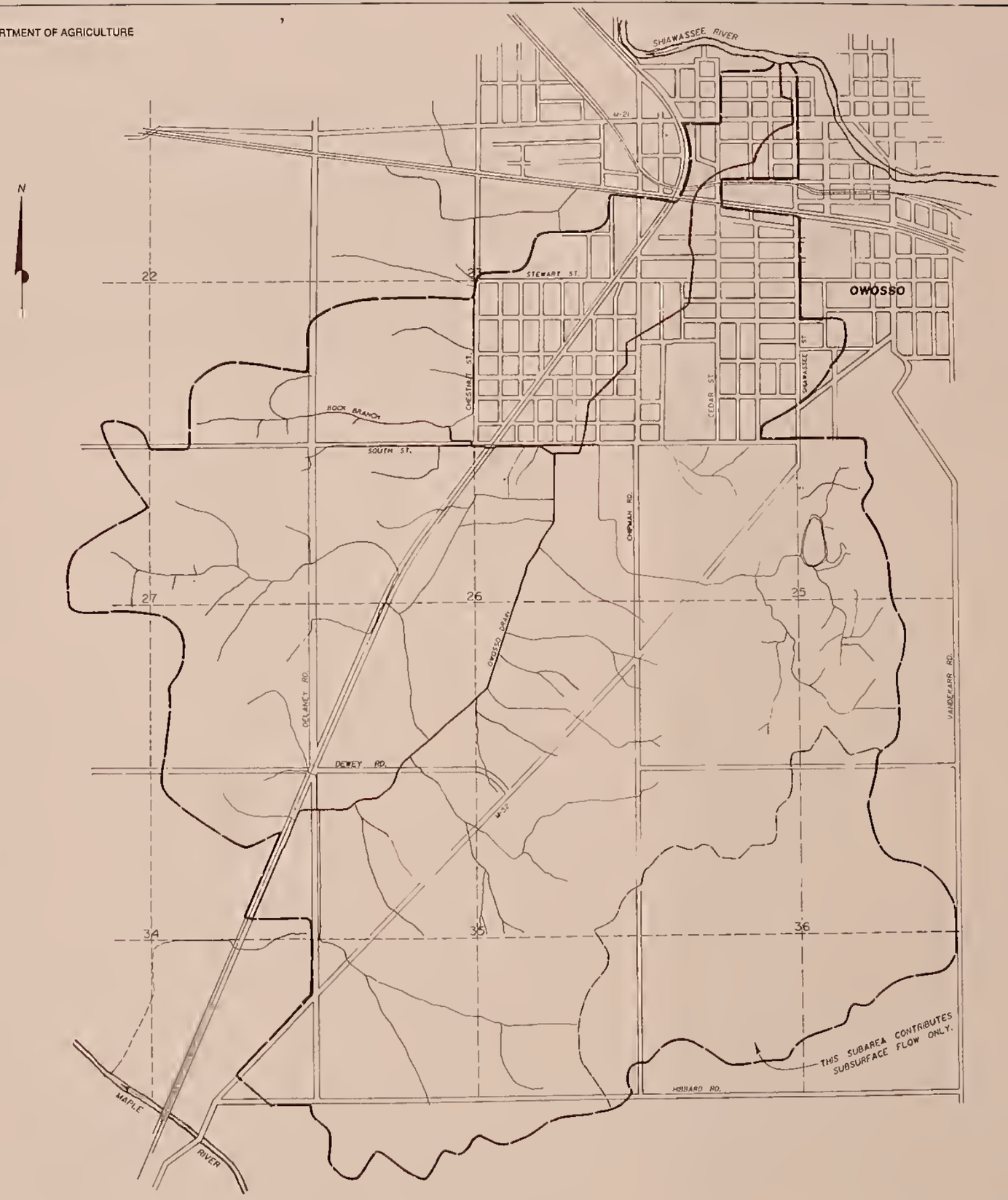
Historically, much of the watershed has been used for agriculture and residential and urban areas. Farming consists primarily of cash crops; mainly corn and soybeans.

Study Area Flood Plain

The study area is contained within Owosso Township. High water profiles and flood plain delineations were made along the Owosso Drain and Bock Branch for a distance of about 4 1/2 miles. The study area is identified on Figure 1.

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE



VICINITY MAP

LEGEND

- Road
- Storm Sewer
- Open Drain
- Railroad
- Watershed Boundary
- Narrow Stream
- Subarea Boundary
- Study Reaches

FIGURE 1

STUDY AREA MAP

Owosso Drain

FLOOD PLAIN MANAGEMENT STUDY

SHIAWASSEE COUNTY, MICHIGAN

1000 500 0 1000 2000

Approximate Scale - Feet

500 0 500

Approximate Scale - Meters

BASE COMPILED FROM DEPARTMENT OF ENGINEERING, OWOSSO, MICHIGAN, OWOSSO AND COMSTOCK DRAINAGE DISTRICT MAP.

1008088-01

USDA-NRCS, NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TEXAS, 1995

NATURAL VALUES 1/

The Owosso Drain is a slow-moving second class warm-water stream. The associated flood plain of Owosso Drain provides a number of beneficial functions including flood storage, wildlife habitat and filtering for maintaining water quality.

The Owosso Drain has a very limited warm-water fishery. The watershed contains a mixture of wildlife habitats including agricultural, forested and urban areas. Wildlife species found in the watershed include white-tail deer, cottontail rabbit, red fox, fox and red squirrel, raccoon, woodchuck, songbirds and ringnecked pheasants.

Presently, this area is used very little for recreational purposes. However, because of its location next to the city of Owosso, there is a very good potential for recreational development.

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1/ Information from Owosso Drain Watershed Tri-Agency Team Report dated April 1994 by Lynn Sampson, State Biologist, SCS, Michigan.

FLOOD PROBLEMS

Annual flooding occurs in the early spring due to a combination of snowmelt and rainfall, and occasionally in the fall due to heavy rains.

Flood damages along Owosso Drain in the city of Owosso and Owosso Township are very heavy. The 100-year flood inundates approximately 458 acres. Three-hundred seventeen residences would experience flooding during a 100-year flood. Dewey Road and South Street would be impassible in the event of a 100-year flood.

This study provides high water profiles and areas subject to flooding based on analyses of existing stream and storm sewer hydraulics and current watershed and flood plain conditions. Water surface profiles along the study reaches are shown for the 10-year, 50-year, 100-year and 500-year flood events. The approximate areas of inundation for two floods, the 100-year and 500-year, are shown on the Flood Hazard Maps.

There are areas in Owosso Township that are flood-prone and are not shown in this report. These flood-prone areas are a result of soil and high water table conditions. The Soil Survey of Shiawassee County, issued in June 1974, describes and delineates these areas.

Typical valley sections shown in Appendix B indicate the effects of the four floods. Flood discharges used for computing high water profiles in the study area are shown in Table 1 in Appendix C. Table 2 in Appendix C shows flood elevations at each of the surveyed valley sections for present conditions.

Floodways have been delineated for Owosso Drain and have been provided to the Sponsors in a separate report.

While no computations were made to reflect the problems of ice and debris blockage at bridges, because of the wide possible variations in conditions, a few generalized comments can be made. Ice and debris can often totally block an opening. To determine possible effects, look at the high water profile sheets. At each bridge or culvert, a "low point or road overflow" symbol is shown. Based on field surveys, this is the elevation at which the road would flood. If there is no culvert capacity available, all flows would need to go over the road through this low section. The depth of flow and flooding would depend on the quantity of flow, as well as the cross-sectional area available for flow.

DETERMINATION OF FLOOD HAZARD FOR SPECIFIC LOCATION

To determine flood levels for a specific location, locate the area of concern on the sheet index, Figure 2 (Appendix A). Select the appropriate flood hazard photomap. Using this photomap, locate the area of concern on the map and its relationship to the nearest identification point (cross-section, road).

For those areas within the flood hazard boundaries, refer to the adjacent high water profile and locate the area of concern on the profile. The mean sea level flood elevation can then be determined for the appropriate flood event. Table 4 (Appendix C) shows flood elevations at each cross-section.

If the specific location is outside the flood hazard boundaries, there is no apparent flood hazard, unless the area is subject to high water table conditions (see soil survey report) or localized flooding.

EXISTING FLOOD PLAIN MANAGEMENT

Both the city of Owosso and Owosso Township participate in the National Flood Insurance Program. The Uniform Building Code is enforced in the city of Owosso and the State Building Code is enforced in Owosso Township. The flood plain management study will provide the information needed to enforce both of these existing building codes.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

The objectives of flood plain management are to reduce the damaging effects of floods, preserve and enhance natural values and provide for optimal use of land and water resources within the flood plain. Flood plain management can minimize potential flood damages by:

1. Prohibiting uses which are dangerous to public health or safety in times of flood.

2. Restricting building or other development which may cause increased flood heights or velocities.

3. Requiring that public or private facilities that are vulnerable to floods be protected against flood damage at the time of construction.

4. Protecting individuals from investments in flood hazard areas which are unsuited for their intended purposes.

5. Providing information on flood-proofing techniques for existing structures in the flood plain.

There are numerous flood plain management alternative categories and tools that can be employed to accomplish the above objectives and goals. The ones that apply to this area are suggested below. Other flood plain management techniques should be considered and may well prove to be effective in reducing or preventing flood damages. Many of the road crossings should be resized when replacement is necessary. These alternatives may not completely solve the flooding problems but will help reduce flooding damages.

Present Condition

This is the "no change" alternative, which reflects ongoing flood plain development pressures and management trends. Local governmental units can continue to plan, zone and accept or reject requests for alternative flood plain and adjacent land uses. Flood problems may continue to increase if development continues.

Land Treatment

This alternative discusses opportunities to minimize or decrease changes in upland runoff and erosion because of land use changes. The traditional approach of accelerating conservation land treatment, by working with landowners to install conservation practices, will minimize soil erosion and reduce runoff. Installation of such measures as tree planting, windbreaks, forest management, permanent vegetative cover and on-site water storage will all reduce runoff, erosion and sedimentation.

As rural areas urbanize, the increase in peak discharges due to more efficient conveyance paths and increased impervious areas can have a significant adverse impact on downstream areas. There is a growing interest on the part of planners, developers and the public in protecting downstream areas from induced flood damages that may accompany increased peaks and stages. Planning authorities are proposing local ordinances that restrict the type and amount of development permitted and the impact development can have on the watershed. One of the primary controls that could be imposed is that future-condition discharges cannot exceed present-condition discharges at some predetermined frequency of occurrence at specified points on the channel.

Methods to control runoff in urbanizing areas reduce either the volume or the rate of runoff. The effectiveness of any control method depends on the available storage, the outflow rate and the inflow rate. Because a great variety of methods can be used to control peak flows, each method proposed should be evaluated for its effectiveness in the given area.

MEASURES FOR REDUCING AND DELAYING URBAN STORM RUNOFF

Area	Reducing Runoff	Delaying Runoff
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lots 3. Ponding and detention measure for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Ground water recharge a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions	1. Reservoir or detention basins 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters or diversions

Preservation and Restoration of Natural Values

Flood plains, in their natural or relatively undisturbed state, provide three broad sets of natural and beneficial resources and resource values.

Water resource values include natural moderation of floods, water quality maintenance and ground water recharge. The physical characteristics of the flood plain shape flood flows. Flood plains generally provide a broad area to spread out and temporarily store flood waters. This reduces flood peaks and velocities and the potential for erosion.

Flood plains serve important functions in protecting the physical, biological and chemical integrity of water. A vegetated flood plain slows the surface runoff, causing it to drop most of its sediment load on the flood plain. Pathogens and toxic substances entering the main water body through surface runoff and accompanying sediments are decreased.

The natural flood plain has surface conditions favoring local ponding and flood detention, plus subsurface conditions favoring infiltration and storage. The slowing of runoff provides additional time for it to infiltrate and recharge available ground water aquifers, and also provides for natural purification of the waters.

Flood plains support large and diverse populations of plants and animals. In addition, they provide habitat and critical sources of energy and nutrients for organisms in adjacent and downstream terrestrial and aquatic ecosystems. The wide variety of plants and animals supported directly and indirectly by flood plains constitutes an extremely valuable, renewable resource important to economic welfare, enjoyment and physical well-being.

The flood plain is biologically important because it is the place where land and water meet and the elements of both terrestrial and aquatic ecosystems mix. Shading of the stream by flood plain vegetation moderates water temperatures; roots and fallen trees provide instream habitat; and near stream vegetation filters runoff, removing harmful sediments and buffering pollutants, to further enhance instream environments.

Flood plains contain cultural resources important to the nation and to individual localities. Native American settlements and early cities were located along the coasts and rivers in order to have access to water supply, waste disposal and water transportation. Consequently, flood plains include most of the nation's earliest archaeological and historical sites. In addition to their historical richness, flood plains may contain invaluable resources for scientific research. For example, where flood plains contain unique ecological habitats, they make excellent areas for scientific study. Flood plains may provide open space community resources. In urban communities, they may provide green belt areas to break urban development monotony, absorb noise, clean the air and lower temperatures. Flood plain parks can also serve as nature study centers and laboratories for outdoor learning experiences.

It is recommended that several selected open space areas be preserved, especially in the undeveloped areas. Their preservation, in accordance with soil limitations and good land use management, will reduce development hazards, prevent additional future flood damages and enhance the urban environment.

1. Soils with high water tables should be retained in natural vegetation. No commercial or residential construction should take place on these soils since the limitations are severe. The Soil Conservation Service has a detailed soil survey of Shiawassee County. Copies of the material, including maps and interpretations, are available for reference in the Shiawassee County Soil Conservation District Office located at 1900 S. Morrice Road, Owosso, Michigan 48867-8913. This information can be used to determine the kinds of soils in a given area and their limitations for various uses.

2. Upland open space should be retained in the natural state as much as possible.

3. Private wooded areas on steep slopes should be preserved from all development. Destruction of natural cover on these steep slopes usually causes excessive erosion during construction. Preservation of these wooded sites would also enhance housing developments in the area.

4. Developing areas should provide on-site flood water storage to temporarily store additional runoff volumes and peaks created by their urbanization.

5. Undeveloped flood plain areas should be managed for wildlife and recreation. These areas have a high potential for use as an excellent outdoor classroom. The Owosso Drain system is easily accessible to many school and college students.

Non-Structural Measures

1. Develop and implement, or update, a flood plain protection and zoning ordinance based on the 100-year frequency high water profile and the flood plain delineations (Appendix A). Retaining the storage in the existing flood plain area will be necessary if this flood profile is to remain valid. Reducing the storage capacity in the system will tend to increase elevations and discharges above that indicated in this report.

2. Flood-proof existing buildings and residences in the flood plain to reduce flood damages. Some basement windows and doors, floor drains and foundations can be modified to reduce effects of flood waters. Materials and supplies stored in vulnerable positions can be relocated and protected. These modifications can be planned and installed where it is desirable and/or feasible to continue using facilities currently in the flood plain.

3. Plans should be developed for alternate routes for automobile, truck and emergency vehicle traffic around those roads that will be inundated during the flood. This will require cooperation between city, township, county and state officials.

4. Debris, fallen trees and brush should be removed from the floodway at least yearly. Snow and ice from road clearing operations should not be piled in the floodway.

5. Owners and occupants of all types of buildings and mobile homes should obtain flood insurance coverage for the structure and contents, especially if located within or adjacent to the delineated flood hazard areas. The Sponsors should make necessary applications and pass needed resolutions and zoning ordinances to qualify for subsidized federal flood insurance. Contact the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909 for additional information.

Structural Measures 1/

Flood stages can be reduced by improving flow conditions within the channel by increasing the stream and storm sewers' carrying capacity. The following structural alternatives were considered:

1. Extended Wet Detention Pond (Natural Storage Area)

Components of this alternative consist of:

a. Three to five-foot high dike approximately 2,500 feet long, located 50 feet south of South Street and west of the mobile home court.

b. Underground conduits consisting of 2,100 feet of 54-inch Reinforced Concrete Pipe (RCP) and 2,500 feet of 60-inch RCP above Stewart Street.

c. One-thousand five-hundred (1,500) feet of channel improvement at the lower end of the Bock Branch.

d. Two-thousand five hundred (2,500) feet of diversion to outlet the 82-acre subarea north of the Bock Branch and west of Chestnut Street into the wet detention pond.

e. Some property acquisition would be required along Dewey Road. Approximately ten homes would need to either be relocated or purchased and demolished. The property could be converted into parks.

f. Approximately 295 acres of flood easements would be required south of South Street.

g. Relocate storm sewers from the mobile home court to the north.

h. Individual homeowners will need to install backflow devices on any basement drains outletting into the storm sewers. Also, sump pumps would still be required in most homes with basements. The backflow devices and sump pumps would be purchased by the individual homeowners.

This alternative would provide protection from a 100-year flood for 317 homes, create or enhance 295 acres of wetland or wildlife habitat and improve the water quality of the Owosso Drain outletting into the Shiawassee River. The 100-year flood elevation north of Freeman Street would be reduced from 737.1 to 735.5.

Estimated project cost based on 1994 prices is $2.5 million.

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1/ Surveys, engineering computations and cost estimates must be verified during the planning and design phases of this project. Also, construction would be very difficult because there are numerous water lines, gas lines, sanitary sewer lines and storm sewers in the vicinity. In addition, many underground telephone and power lines are in the area. Several streets and roads would need to be completely replaced. Maintenance and repair of the existing sanitary sewer located directly under the storm sewer trunk line will be required to improve water quality of the Owosso Drain.

2. Extended Wet Detention Pond (Excavated)

This alternative consists of all of the components of Alternative 1, except a 39-acre pond would be excavated on city property south of South Street in lieu of obtaining flood easements. The 100-year flood plain south of the city property would not change.

Estimated project cost based on 1994 prices is $3.7 million.

3. Property Acquisition

Approximately 317 homes located in the 100-year flood plain would have to be relocated or purchased and demolished. Approximately 118 acres of park would be created.

Estimated project cost based on 1994 prices is $35 million.

4. Extend Trunk Line

Components of this alternative consist of:

a. 4,800 feet of supplemental 60-inch diameter RCP from the Shiawassee River to the junction box south of Stewart Street.

b. 3,600 feet of twin 6 feet x 8 feet reinforced concrete box culverts from the junction box to South Street.

c. 5,000 feet of 6 feet x 12 feet reinforced concrete box culvert from the outlet of Bock Branch west of Chestnut Street to the west side of the Penn Central Railroad then continuing north along the railroad row and outletting into the trunkline of the Owosso Drain. This underground outlet would drain the Bock Branch, the 82-acre subarea north of the Bock Branch and west of Chestnut Street, and the 115 acre area west of the Penn Central Railroad and east of Chestnut Street.

d. Some property acquisition would still be required along Dewey Road. Approximately ten homes would need to either be relocated or purchased and demolished. The property could be converted into parks.

e. Individual homeowners will still need to install backflow devices on any basement drains outletting into the storm sewers. Also, sump pumps would still be required in most homes with basements. The backflow devices and sump pumps would be purchased by the individual homeowners.

This alternative would provide protection from a 100-year flood for 317 homes.

Estimated project cost based on 1994 prices is $10.2 million.

5. Open Channel

An open channel was considered from South Street to the junction box in lieu of an underground conduit and it was determined not practical due to the shallow channel depth and excessive bottom width requirements.

6. Outlet Into Maple River

This alternative was considered, but is not practical due to excessive cuts required west of Delaney Road.

7. Additional Inlets Into Junction Box

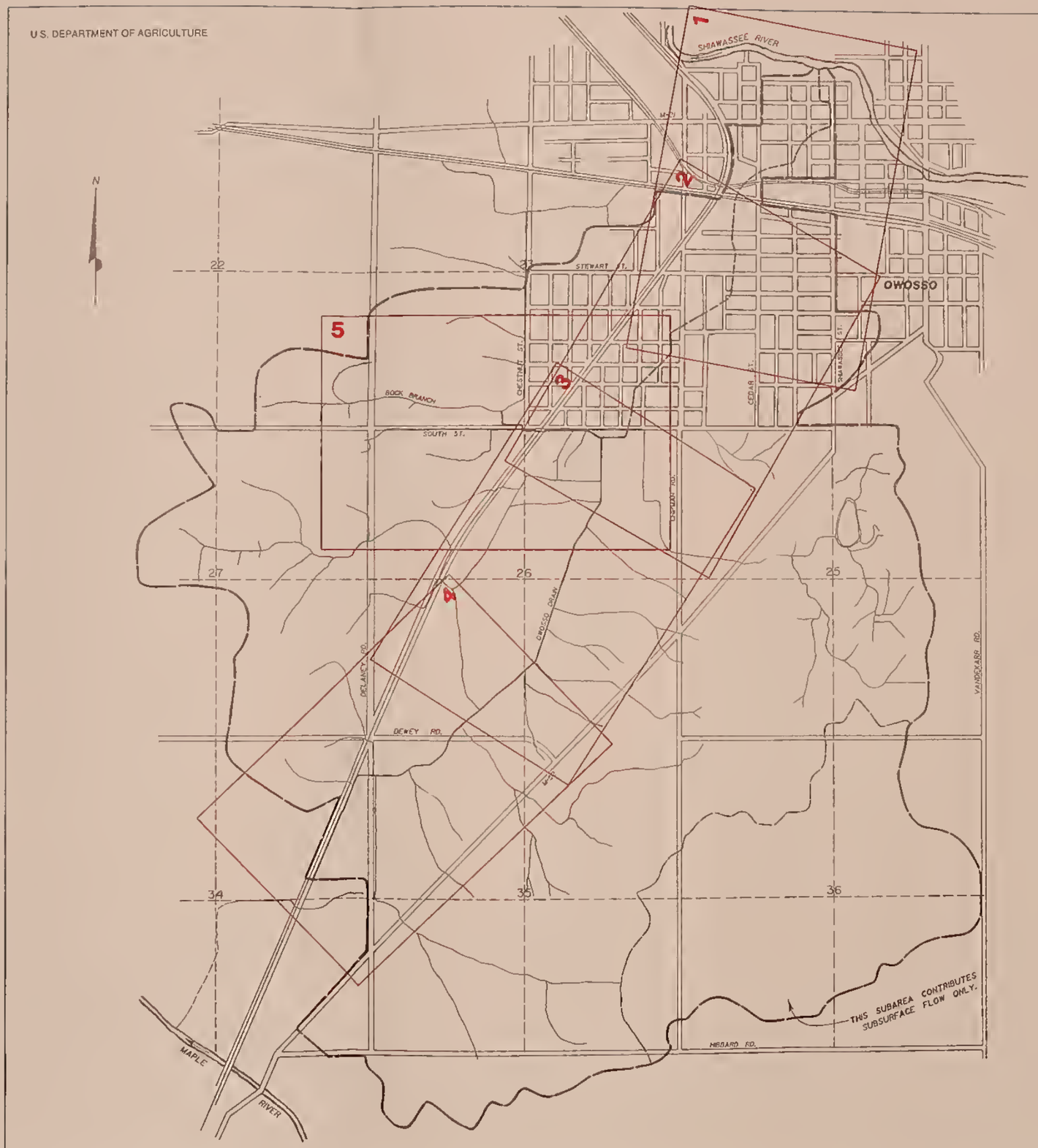
Adding 2 60-inch RCP inlets into the junction box would reduce the 100-year flood plain from 737.1 feet to 736.0 feet from the railroad to Stewart Street. However, overland flooding would still occur from South Street to the junction box.

Estimated project cost based on 1994 prices is $275,000.

APPENDIX A

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE



VICINITY MAP

LEGEND

- Road
- Storm Sewer
- Open Drain
- Railroad
- Watershed Boundary
- Narrow Stream
- Subarea Boundary
- Sheet Coverage [2]

FIGURE 2

PHOTO SHEET INDEX MAP

Owosso Drain

FLOOD PLAIN MANAGEMENT STUDY

SHIAWASSEE COUNTY, MICHIGAN

1000 500 0 1000 2000

Approximate Scale - Feet

500 0 500

Approximate Scale - Meters

BASE COMPILED FROM DEPARTMENT OF ENGINEERING, OWOSSO, MICHIGAN, OWOSSO AND COMSTOCK DRAINAGE DISTRICT MAP.

1008089-02

USDA-NRCS, NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TEXAS, 1995

VALLEY SECTIONS

NOTE: SEE MARCH 1, 1982 FLOOD INSURANCE RATE MAPS FOR FLOOD HAZARD AREAS ALONG THE SHIAWASSEE RIVER.

OUTLET T SHIAWA-SEE RIVER

ELEVATION ABOVE MEAN SEA LEVEL IN FEET U.S.C. & G.S. DATUM of 1929

750
740
730
720
710

GRAND TRUNK WESTERN RAILROAD

10.0

LOW GROUND

manhole

EXISTING CHANNEL BOTTOM

500-YR.
100-YR.
50-YR.
10-YR.

0+00 5+00 10+00 15+00 20+00 25+00 30+00 35+00 40+00 45+00

STATIONS ALONG CENTERLINE IN FEET

TOP OF ROAD
ROADWAY LOW

INLET INVERT
OUTLET INVERT

NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.

HIGH WATER PROFILES
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.D. BOURDON	Date 6/94	Approved By	
Drawn L.A. WILSON	Date 6/94	Title	
Traced		Title	
Checked MDNR	Date 7/94	Sheet No 5 of 5	Drawing No

LEGEND

- 100 YEAR FLOOD HAZARD
- 500 YEAR FLOOD HAZARD
- VALLEY SECTION LOCATION
- STREAM CHANNEL
- 0+00 CHANNEL STATION
- STORM SEWER

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT, THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1991 PHOTOGRAPHY FROM NORTHERN AERIAL SURVEY INC.

SHEET 1 OF 5

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

FLOOD HAZARD AREA

OWOSSO DRAIN

VALLEY SECTIONS

STEWART ST. — 11.0

JUNCTION BOX

FREEMAN ST. — 11.5

SOUTH ST. — 12.0

12.1

ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)

750

740

730

720

manhole

manhole

manhole

manhole

manhole

500-YR.

100-YR.

50-YR.

10-YR.

LOW GROUND

EXISTING CHANNEL BOTTOM

45+00 50+00 55+00 60+00 65+00 70+00 75+00 80+00 85+00 90+00

STATIONS ALONG CENTERLINE IN FEET

TOP OF ROAD
ROAD OVERFLOW

INLET INVERT
OUTLET INVERT

NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.

HIGH WATER PROFILES
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.D. BOURDON	Date 6/94	Approved By	
Drawn L.A. WILSON	6/94	Title	
Traced		Title	
Checked MDNR	7/94	Sheet No 2 of 5	Drawing No

LEGEND

- 100 YEAR FLOOD HAZARD
- 500 YEAR FLOOD HAZARD
- VALLEY SECTION LOCATION
- STREAM CHANNEL
- 0+00 CHANNEL STATION
- STORM SEWER

NOTE:
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SCALE 0 400 800 FEET
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1991 PHOTOGRAPHY FROM NORTHERN AERIAL SURVEY INC.

SHEET 2 OF 5

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

FLOOD HAZARD AREA

OWOSSO DRAIN

USDA-NRCS, NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TEXAS, 1995

VALLEY SECTIONS

12.5 | 12.9 | 13.0 | 13.1 | 13.9 | 14.0 | 14.1

FIELD CROSSING

FIELD CROSSING

ELEVATION ABOVE MEAN SEA LEVEL IN FEET (U.S.C. & G.S. DATUM of 1929)

750

740

730

720

500-YR.
100-YR.
50-YR.
10-YR.

LOW GROUND

EXISTING CHANNEL BOTTOM

90+00 | 95+00 | 100+00 | 105+00 | 110+00 | 115+00 | 120+00 | 125+00 | 130+00 | 135+00

STATIONS ALONG CENTERLINE IN FEET

TOP OF ROAD
ROAD OVERFLOW
INLET INVERT
OUTLET INVERT

NOTE:
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HIGH WATER PROFILES
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By
T.D. BOURDON	6/94	Title
Drawn		
L.A. WILSON	6/94	Title
Traced		
Checked		Sheet No. 3 of 5
MDNR	7/94	Drawing No.

LEGEND

100 YEAR FLOOD HAZARD

500 YEAR FLOOD HAZARD

VALLEY SECTION LOCATION

STREAM CHANNEL

0+00 CHANNEL STATION

STORM SEWER

NOTE:
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SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1991 PHOTOGRAPHY FROM
NORTHERN AERIAL SURVEY INC.

SHEET 3 OF 5

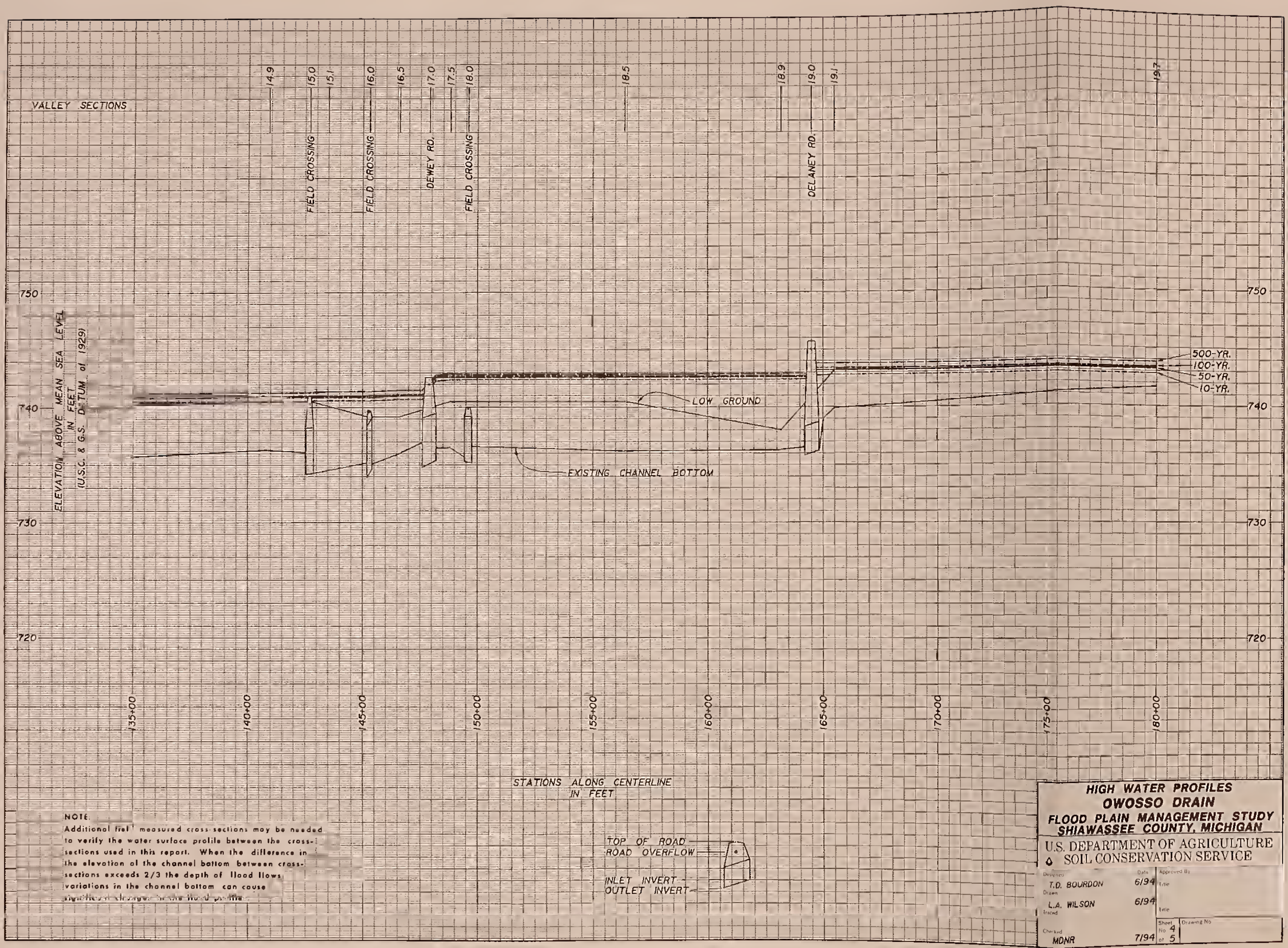
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

FLOOD HAZARD AREA

OWOSSO DRAIN

USDA-NRCS, NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TEXAS, 1995

VALLEY SECTIONS



NOTE:
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HIGH WATER PROFILES
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.D. BOURDON	Date 6/94	Approved By	Title
Drawn L.A. WILSON	6/94		Title
Traced		Sheet No 4 of 5	Drawing No
Checked MDNR	7/94		

LEGEND

- 100 YEAR FLOOD HAZARD
- 500 YEAR FLOOD HAZARD
- VALLEY SECTION LOCATION
- STREAM CHANNEL
- 0+00 CHANNEL STATION

NOTE:
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SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1991 PHOTOGRAPHY FROM NORTHERN AERIAL SURVEY INC.

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

SHEET 4 OF 5

FLOOD HAZARD AREA

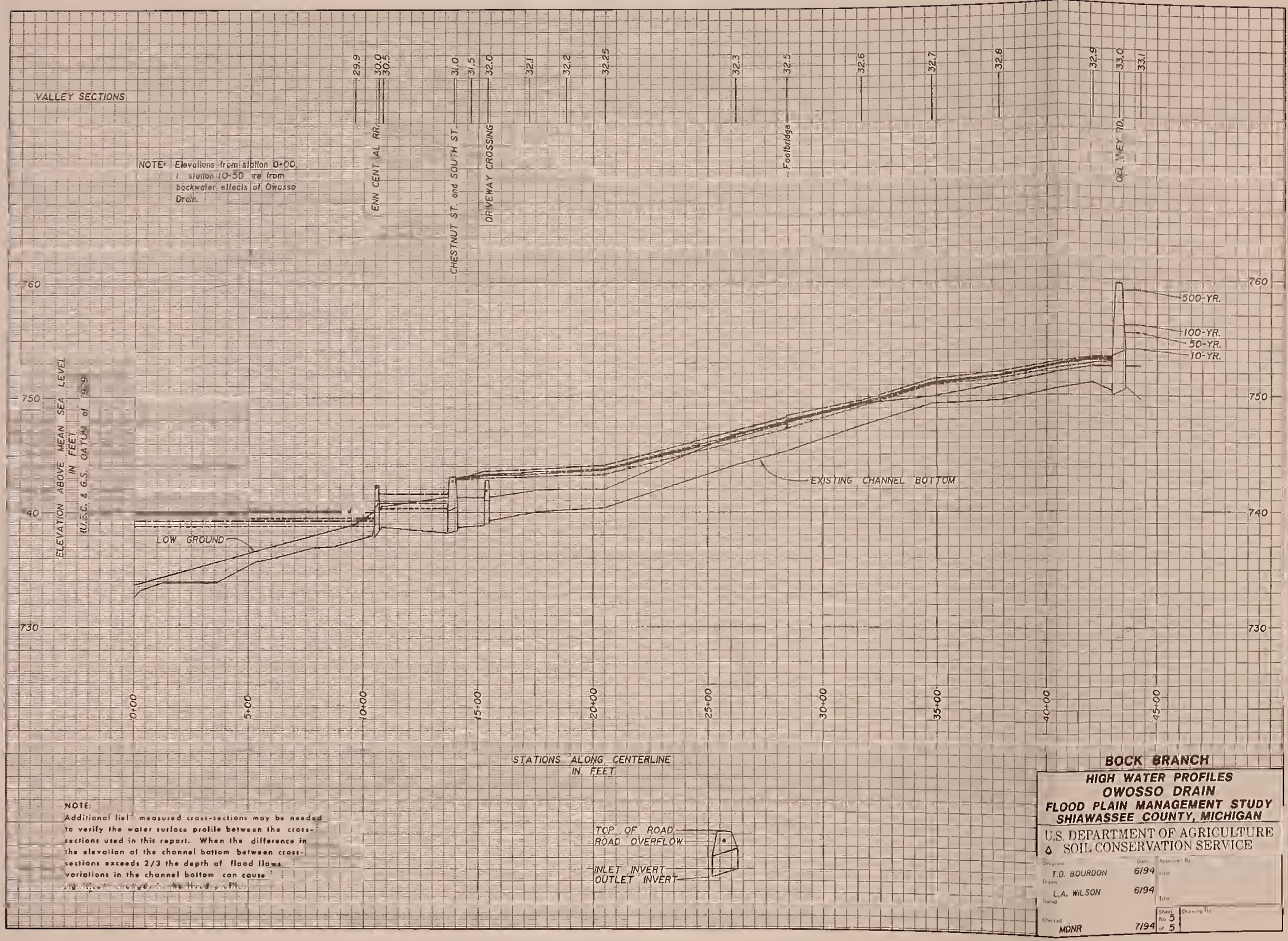
OWOSSO DRAIN

USDA-NRCS, NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TEXAS, 1995

10080088

VALLEY SECTIONS

NOTE: Elevations from station 0+00 to station 10+50 are from backwater effects of Owasso Drain.



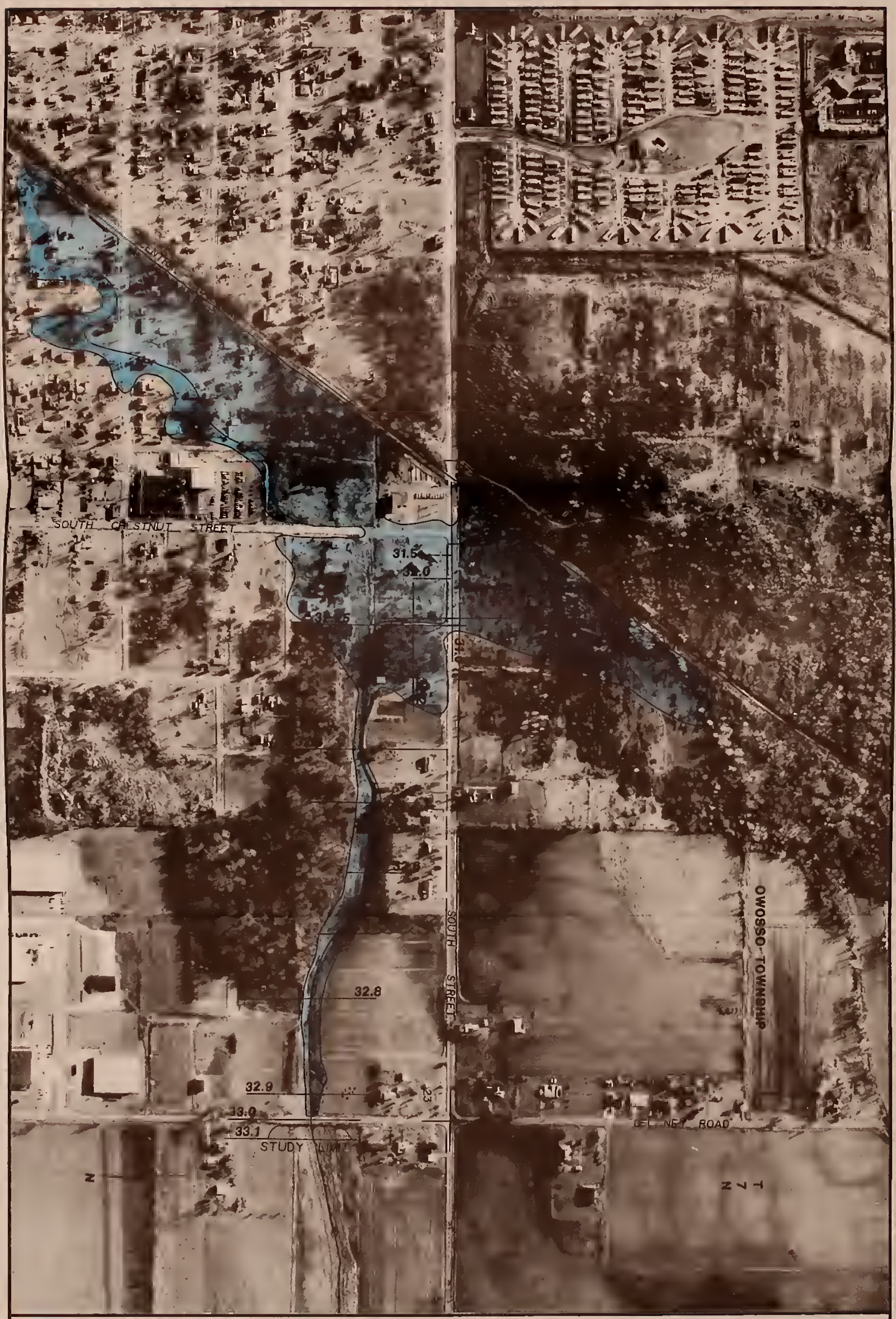
NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows variations in the channel bottom can cause significant changes in the flood profiles.

BOCK BRANCH

HIGH WATER PROFILES
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.D. BOURDON	Date 6/94	Approved By Title	
Drawn L.A. WILSON	6/94	Title	
Traced			
Checked MDNR	7/94	Sheet No. 5 of 5	Drawing No.



LEGEND

- 100 YEAR FLOOD HAZARD
- 500 YEAR FLOOD HAZARD
- VALLEY SECTION LOCATION
- STREAM CHANNEL
- 0+00 CHANNEL STATION

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT, THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1991 PHOTOGRAPHY FROM NORTHERN AERIAL SURVEY INC.

SHEET 5 OF 5

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
OWOSSO DRAIN
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

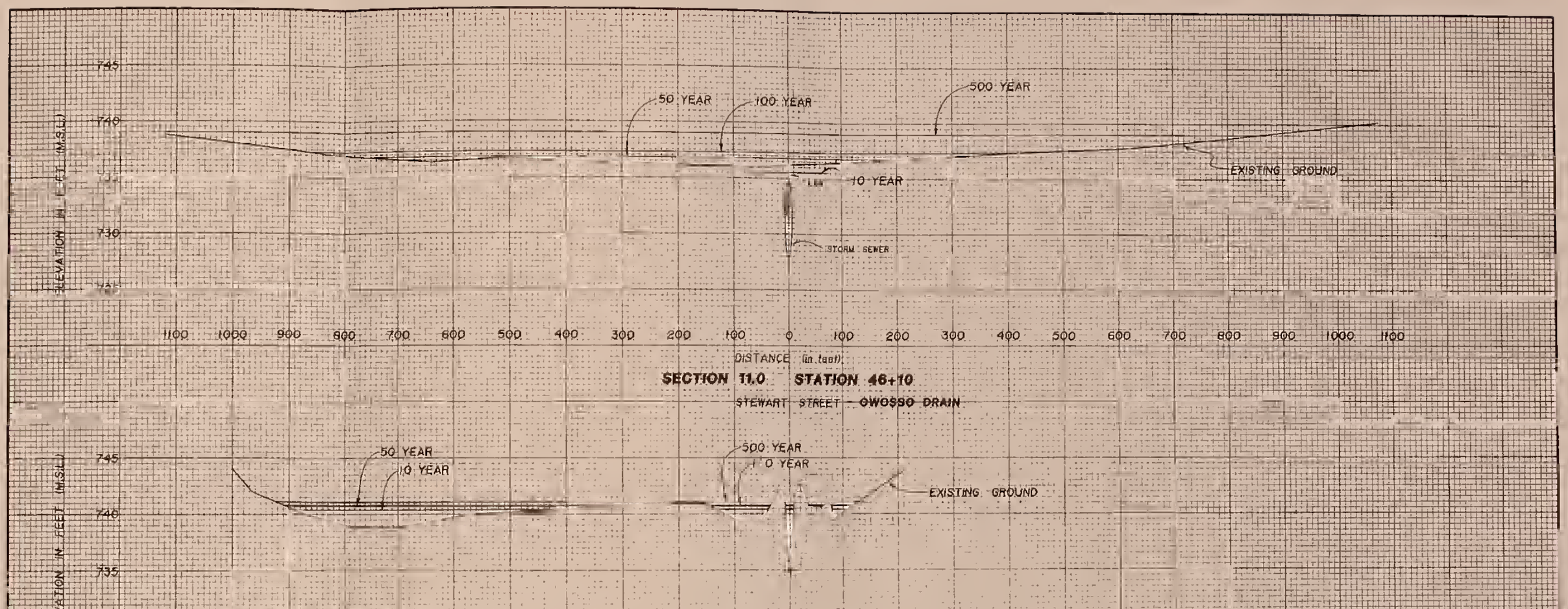
FLOOD HAZARD AREA

OWOSSO DRAIN

USDA-NRCS NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TEXAS 1/93

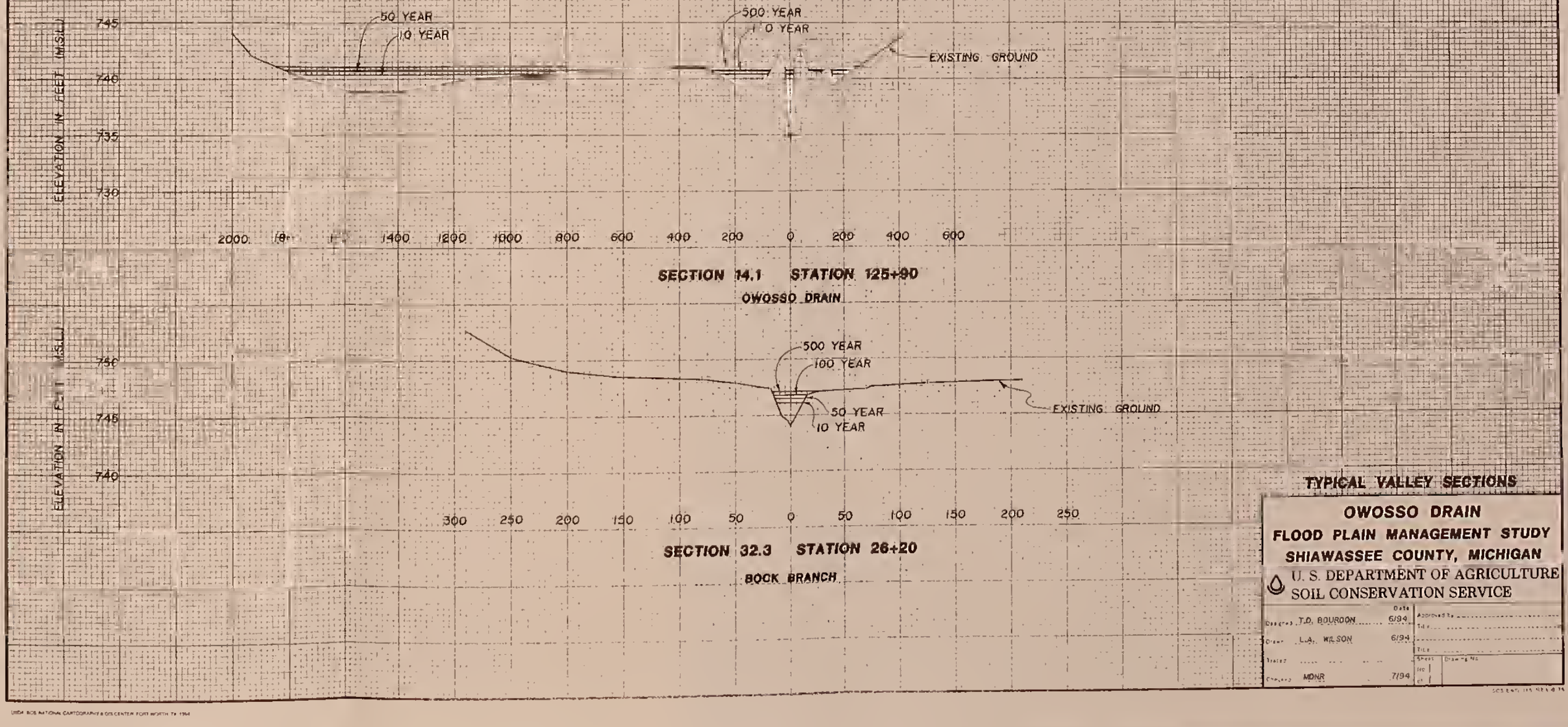
1006083

APPENDIX B



SECTION 11.0 STATION 46+10

STEWART STREET - OWOSSO DRAIN



SECTION 14.1 STATION 125+90

OWOSSO DRAIN

SECTION 32.3 STATION 26+20

BOCK BRANCH

TYPICAL VALLEY SECTIONS

OWOSSO DRAIN

FLOOD PLAIN MANAGEMENT STUDY

SHIAWASSEE COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	T.D. BOURDON	6/94
Drawn	L.A. WILSON	6/94
Traced		
Checked	MDNR	7/94

Approved By
Title
Title
Sheet
No.
Drawing No.

APPENDIX C

TABLE 1 - FLOOD DISCHARGES

Location	TR-20 Sec.	From Sec.	To Sec.	Drainage Area Sq. Miles	Estimated Peak Discharges Cubic Feet Per Second 10-Yr	50-Yr	100-Yr	500 Yr
OWOSSO DRAIN								
Into Struc. 1 1/	004	19.7	US19.0	0.23	90	150	180	260
Out of Struc. 1	Struc. 1			0.23	35	35	35	35
Into Struc. 2 2/	007	DS19.0	US17.0	1.41	270	460	550	790
Out of Struc. 2	Struc. 2			1.41	150	305	375	570
To Sta. 106+60	016	DS17.0	US13.0	3.02	200	335	405	600
Into Struc. 3 3/	011	___	___	0.44	115	160	195	305
Out of Struc. 3	Struc. 3			0.44	10	15	20	25
Into Struc. 5 5/	025	DS13.0	US11.5	3.85	300	520	630	935
Out of Struc. 5 5/	Struc. 5			3.85	145	230	270	425
Into Struc. 6 6/	030	DS11.5	US10.0	4.40	195	320	375	520
Out of Struc. 6	Struc. 6	DS10.0	9.0	4.40	205	230	250	290
At Shiawassee River	031			4.68	310	385	410	485
BOCK BRANCH								
Delaney Road	019	33.1	32.9	0.13	40	65	75	105
DS Delaney Rd. to US South St.	022	32.8	US31.0	0.22	55	95	110	160
Into Struc. 4 4/	024	DS31.0	US30.0	0.39	105	170	205	290
Out of Struc. 4	007			0.39	25	30	35	40

1/ Natural detention area south of Dewey Road and west of Delaney Road
2/ Natural detention area south of Dewey Road
3/ Hopkins Lake
4/ Natural detention area southwest of the intersection of South Street and the Penn Central railroad tracks
5/ From Farm Lane Crossing at station 106+60 to US Freeman Street
6/ From Freeman Street to Penn Central Railroad

TABLE 2 - FLOOD ELEVATION AT SECTIONS

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
		OWOSSO DRAIN				
Grand Trunk Western Railroad	10.0 U	32+90	735.5	736.4	737.1	738.6
Stewart Street	11.0	46+10	735.5	736.4	737.1	738.6
Freeman Street	11.5 D	68+45	735.5	736.4	737.1	738.6
	11.5 U	68+75	738.8	739.3	739.5	740.0
South Street	12.0	81+70	738.8	739.3	739.5	740.0
	12.1	84+00	738.8	739.3	739.5	740.0
	12.5	100+90	738.8	739.3	739.5	740.0
	12.9	105+60	738.8	739.3	739.5	740.0
Farm Lane Crossing	13.0 D	106+60	738.8	739.3	739.5	740.0
	13.0 U	107+00	740.1	740.2	740.2	740.3
	13.1	108+00	740.1	740.2	740.3	740.4
	13.9	122+93	740.3	740.6	740.7	741.0
Farm Lane Crossing	14.0 D	124+23	740.3	740.6	740.7	741.0
	14.0 U	124+57	740.4	740.7	740.8	741.1
	14.1	125+90	740.4	740.7	740.8	741.1
	14.9	140+90	740.5	740.9	741.0	741.3
Farm Lane Crossing	15.0 D	142+53	740.5	740.9	741.0	741.3
	15.0 U	142+87	740.6	740.9	741.0	741.3
	15.1	143+50	740.6	740.9	741.0	741.4
Farm Lane Crossing	16.0 D	145+20	740.6	740.9	741.0	741.4
	16.0 U	145+40	740.6	740.9	741.1	741.4
	16.5	146+60	740.7	741.0	741.1	741.5
Dewey Road	17.0 D	147+61	740.7	741.0	741.1	741.5
	17.0 U	148+19	742.3	742.6	742.7	742.8
	17.5	148+80	742.4	742.6	742.7	742.9
Farm Lane Crossing	18.0 D	149+44	742.4	742.6	742.7	742.9
	18.0 U	149+76	742.4	742.6	742.7	742.9
	18.5	156+40	742.4	742.6	742.7	742.9
	18.9	163+18	742.4	742.6	742.7	742.9
Delaney Rd.	19.0 D	164+18	742.4	742.6	742.7	742.9
	19.0 U	164+82	742.7	743.2	743.4	743.8
	19.1	165+50	742.8	743.2	743.4	743.8
	19.7	180+00	742.8	743.2	743.4	743.8

TABLE 2 - FLOOD ELEVATION AT SECTIONS - CONTINUED

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
			BOCK DRAIN			
	29.9	9+60	738.8	739.3	739.5	740.0
Penn Central Railroad	30.0 D	10+50	738.8	739.3	739.5	740.0
	30.0 U	10+70	740.3	740.8	741.0	741.6
	30.5	10+80	740.3	740.8	741.0	741.6
South Street	31.0 D	13+68	740.3	740.8	741.0	741.6
	31.0 U	14+12	742.9	742.9	743.0	743.0
	31.5	14+65	742.9	743.0	743.1	743.2
Drive	32.0 D	15+28	743.0	743.2	743.3	743.6
	32.0 U	15+52	743.0	743.2	743.3	743.6
	32.1	17+20	743.1	743.3	743.5	743.7
	32.2	18+80	743.2	743.5	743.6	743.9
	32.25	20+50	743.3	743.7	743.8	744.1
	32.3	26+20	746.1	746.5	746.7	747.1
Footbridge	32.5 D	28+42	747.2	747.7	747.8	748.2
	32.5 U	28+46	747.3	747.9	748.0	748.4
	32.6	31+70	749.2	749.4	749.5	749.7
	32.7	34+80	751.0	751.1	751.2	751.5
	32.8	37+80	751.5	751.7	751.8	752.1
	32.9	42+10	752.8	753.1	753.2	753.3
	33.0 D	43+00	752.9	753.1	753.2	753.3
	33.0 U	43+60	754.0	755.4	756.1	759.1
	33.1	44+25	754.0	755.4	756.1	759.1
			HOPKINS LAKE			
			761.9	762.2	762.4	762.7

APPENDIX D

INVESTIGATIONS AND ANALYSIS

Survey Procedures

Field surveys were made of bridges, roads, structures, channels and flood plains of the Owosso Drain and Bock Branch by the Soil Conservation Service in October 1992 and completed in July 1993. Temporary bench marks, based on USC and GS mean sea level elevation data of 1929, were established using second order accuracy. Temporary bench marks are described in Part 4 of this Technical Report. For Owosso Drain and Bock Branch 48 road bridges and valley cross-sections were surveyed. In addition, 2-foot contour maps were provided by the city of Owosso.

Hydrology and Hydraulics

Physical data were obtained from USGS topographic maps and soil survey maps, as well as on-site field inspections. The watershed boundary was determined from map studies and field checks. The watershed was divided into 16 sub-watershed areas for use in evaluating the runoff volumes. Drainage areas for the sub-watersheds were measured from USGS topographic maps. Times of concentration were calculated for the sub-watersheds using the Soil Conservation Service TR55 Computer Module and Manning's Formula. Each sub-watershed was evaluated for land use, cover and soils. Runoff curve numbers were calculated using TR55 as described in Part 7 of the technical documentation book.

Channel flood routings to establish peak discharge-frequency relationships were made using the PC version of the SCS TR-20 Hydrology Computer Program dated September 1, 1983. The Modified Attenuation-Kinematic (Att-Kin) method of routing through stream channels is used by this program. This method is derived from inflow-outflow hydrograph relationships. The SCS WSP-2 computer program was used to obtain stage-discharge relationships. The TR-20 computer program uses these data and the Storage-Indication Method of evaluating the effect of the structures in reducing peak flood discharges. Elevation-storage relationships for the structures were obtained from USGS quadrangle maps and contour maps. Six natural storage areas were treated as structures in the TR-20 model. They have a significant impact on peak discharges and flood elevations. The TR-20 Flood Routing Schematic can be found in Part 12 of the technical support documentation. Table 3, in Appendix C, lists discharges obtained from the flood routings and Table 4, in Appendix C, lists flood elevations at sections located in the study area. According to information found on page 164, Water Resources Data, Mich. 1992, USGS Water Data Report MI-92-1, base flow is 0.64 cfs/sq. mi. Due to the small size of this watershed (4.68 sq. mi.) base flow was not considered.

The TR-20 model was used to reproduce elevations from the October 1, 1981 flood event and has been accepted as a basis of the hydrology and flood routing for the Owosso Drain and Bock Branch. Hourly rainfall information from the weather station at Owosso, Michigan was used to model the flood. The predicted flood elevation was within 0.2 foot of the observed elevation. The Antecedent Moisture Condition (AMC) for the time before the storm was determined from the rainfall data. The AMC is based upon the 5-day antecedent rainfall before the storm event. From the rainfall data, the AMC was AMC II.

Separate water surface profiles for Owosso Drain and Bock Branch were developed using the SCS WSP-2 computer program. This program uses the step method of computation to solve the Bernoulli Equation, and the Bureau of Public Roads bridge loss analysis. Flood discharges determined from flood routings were used in the water surface profile program to develop high water profiles along the channel. Manning's "n" values were determined from photographs and field investigations of the channel and flood plain.

A 24-inch Reinforced Concrete Pipe (RCP) under the Penn Central Railroad located approximately 3,000 feet south of Dewey Road allows backwater from the Maple River to enter the Owosso Drain; however, according to interviews with local residents, backwaters from the Maple River have never topped the railroad. Since any backwater from the Maple River entering the Owosso Drain would occur several hours after the Owosso Drain peaks, the effects on flood elevations and peak discharges along the Owosso Drain would be minimal. It should also be noted that flood waters from the Owosso Drain will exit the Owosso Drain Watershed and enter the Maple River through the 24-inch RCP during major storm events. Again, due to the limited capacity of the 24-inch RCP the effects would be very minimal and were ignored in this analysis.

Normal bridge and channel flow conditions were assumed in the hydraulic computations. No consideration was made for openings blocked by ice or other debris. Channel and flood plain flow characteristics may change due to vegetative growth, sedimentation, scour, debris accumulation, filling and encroachment. Computations for this study considered only those features in the flood plain at the time of the field surveys. Future flood plain developments and modifications, as well as changes in the upstream drainage areas and land use and cover will require recomputation of water surface profiles.

Flood plain delineations were made on the photo maps. Computed water surface elevations at surveyed sections and bridges were used to identify flood plain limits. Between sections, topographic map interpretations and field inspections were used to delineate the flood boundary lines. Limits of flooding shown on the photo maps may vary from true ground location due to inherent photographic displacement. High water profile elevations and detailed field surveys should be used to determine the extent or depth of flooding at any specific site.

The limits of the 100-year and 500-year floods were too close to delineate, and the limits of the two flood plains are shown as the same line on the quadrangle sheet.

APPENDIX E

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

VICINITY MAP

LEGEND

- Road
- Storm Sewer
- Open Drain
- Railroad
- Watershed Boundary
- Narrow Stream
- Subarea Boundary
- Bench Mark • TBM 24

FIGURE 3

BENCH MARK LOCATION MAP
Owosso Drain
FLOOD PLAIN MANAGEMENT STUDY
SHIAWASSEE COUNTY, MICHIGAN

1000 500 0 1000 2000
Approximate Scale - Feet

500 0 500
Approximate Scale - Meters

BASE COMPILED FROM DEPARTMENT OF ENGINEERING, OWOSSO, MICHIGAN, OWOSSO AND COMSTOCK DRAINAGE DISTRICT MAP.

1008068-03

USDA-NRCS, NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TEXAS, 1995

BENCH MARK DESCRIPTIONS *

OWOSSO DRAIN

SHIAWASSEE COUNTY, MICHIGAN

BM USGS 727

Southeast corner of SW 1/4 of Section 13, T7N, R2W - Located on northwest corner of the intersection of M-21 and M-52. Iron post with a bronze cap stamped "727", located one foot east of the northeast corner of the Public Library.

Elev. 726.88

TBM 1

Section 13, T7N, R2W - Top of northeast bonnet bolt of fire hydrant, located on northeast corner of the intersection of M-52 and Curwood Castle Road. Approximately 40 feet east of 1/4 section line of Section 13 and 730 feet north of centerline of M-21.

Elev. 725.64

TBM 2

Section 13, T7N, R2W - Top of northeast bonnet bolt of fire hydrant located between sidewalk and west side of M-52. Approximately 25 feet north of Mitchell Park entrance and west of Williams Road "T" intersection. Approximately 30 feet west of 1/4 section line of Section 13, and approximately 1150 feet north of centerline of M-21.

Elev. 735.81

TBM 3

Section 13, T7N, R2W - Northwest corner of headwall of 1.6 foot diameter concrete culvert on north bank of Shiawassee River. Approximately 25 feet west of northwest corner of M-52 bridge over Shiawassee River. Approximately 70 feet west of 1/4 section line and 1050 feet north of centerline of M-21.

Elev. 724.19

* Elevations based on USC & GS mean sea level datum of 1929.

TBM 4

Section 24, T7N, R2W - Top of northeast bonnet bolt of fire hydrant located on the south side of M-21. Located southeast of "T" intersection of M-21 and Johns Street. Approximately 350 feet east of 1/4 section line and approximately 40 feet south of centerline of M-21.

Elev. 730.70

TBM 5

Section 13, T7N, R2W - On the northwest corner of the M-21 bridge over Shiawassee River. Painted chiseled square in northeast corner of the top of the northwest abutment. Approximately 650 feet east of 1/4 section line and approximately 40 feet north of centerline of M-21.

Elev. 731.54

TBM 6

NE corner of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the southwest corner of M-21 and M-52.

Elev. 731.05

TBM 7

NE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt of top bonnet ring of fire hydrant located on the southwest corner of M-21 and South Elm Street.

Elev. 734.79

TBM 8

NE 1/4 of NE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt of top bonnet ring of fire hydrant located on the southwest corner of the intersection of Clinton Street and South Elm Street.

Elev. 733.64

TBM 9

N 1/2 of NE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt of bonnet ring on fire hydrant located on the northeast corner of the intersection of Clinton Street and South Howell Street.

Elev. 735.86

TBM 10

NW 1/4 of NE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt of bonnet ring of fire hydrant located on the southeast corner of "T" intersection of South Cedar Street and Clinton Street.

Elev. 741.97

TBM 11

SW 1/4 of NE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt of top bonnet ring of fire hydrant located on the northeast corner of the "T" intersection of South Cedar Street and Cass Street.

Elev. 739.38

TBM 12

NW corner of SE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt of top bonnet ring of fire hydrant located on the southeast corner of the intersection of South Cedar Street and City Yard Drive.

Elev. 741.83

TBM 13

West side of SE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt on top bonnet ring of fire hydrant located on the northeast corner of the intersection of South Cedar Street and Fletcher Street.

Elev. 742.45

TBM 14

West side of SE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt on top bonnet ring of fire hydrant located on the northeast corner of the intersection of South Cedar Street and Ryan/Thomas Street.

Elev. 739.62

TBM 15

SW corner of SE 1/4 of NW 1/4 of Section 24, T7N, R2W - Top of northeast bolt of top bonnet ring of fire hydrant located on the northeast corner of the intersection of South Cedar Street and West Stewart Street.

Elev. 738.96

TBM 16

NE 1/4 of NW 1/4 of SW 1/4 of Section 24, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the southeast corner of the "T" intersection of West Stewart Street and South Lyon Street.

Elev. 737.39

TBM 17

NE 1/4 of NW 1/4 of SW 1/4 of Section 24, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northeast corner of the "T" intersection of South Lyon Street and Ament Street.

Elev. 738.22

TBM 18

NE 1/4 of NW 1/4 of SW 1/4 of Section 24, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northeast corner of the "T" intersection of South Lyon Street and Grace Street.

Elev. 738.29

TBM 19

SW 1/4 of NW 1/4 of SW 1/4 of Section 24, T7N, R2W - Top of northeast bolt on top bonnet ring of fire hydrant located on the northeast corner of the intersection of Clyde Street and State Street.

Elev. 739.10

TBM 20

SE 1/4 of NE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northwest corner of the intersection of South Chipman Street and Frederick Street.

Elev. 740.23

TBM 21

SW 1/4 of SE 1/4 of NE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northwest corner of the intersection of Frederick Street and Kenwood Drive. Approximately 410 feet west and 1485 feet north of the southeast corner of Section 23.

Elev. 739.26

TBM 22

NW 1/4 of NE 1/4 of SE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northeast corner of the interaction of Kenwood Drive and Freeman Street. Approximately 340 feet west and 1090 feet north of the southwest corner of Section 23.

Elev. 739.61

TBM 23

SW 1/4 of NE 1/4 of SE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northeast corner of the "T" intersection of Kenwood Drive and Herman Street. Approximately 340 feet west and 770 feet north of southeast corner of Section 23.

Elev. 742.66

TBM 24

SE 1/4 of NW 1/4 of SE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northeast corner of the intersection of Herman Street and George Street. Approximately 710 feet west and 760 feet north of southeast corner of Section 23.

Elev. 739.48

TBM 25

NW 1/4 of SE 1/4 of SE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northeast corner of the "T" intersection of George Street and Hiram Street. Approximately 640 feet west and 335 feet north of the southeast corner of Section 23.

Elev. 742.21

TBM 26

SW 1/4 of SE 1/4 of SE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt of bonnet ring of fire hydrant located on the northeast corner of the "T" intersection of George Street and South Street. Approximately 625 feet east and 25 feet north of the southeast corner of Section 23.

Elev. 739.74

TBM 27

SE 1/4 of SW 1/4 of SE 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant located on the northeast corner of the "T" intersection of South Street and Nelson Street. Approximately 1020 feet east and 30 feet north of the southeast corner of Section 23.

Elev. 739.60

TBM 28

SE 1/4 of SE 1/4 of SW 1/4 of SE 1/4 of Section 23, T7N, R2W - Top of northeast bolt on bonnet ring of fire hydrant on the northeast corner of the "T" intersection of South Street and Carr Street. Approximately 1335 feet east and 30 feet north of the southeast corner of Section 23.

Elev. 738.87

TBM 29

SW 1/4 of SW 1/4 of SW 1/4 of SE 1/4 of Section 23, T7N, R2W - SCS nail and disk in south side of post on the southwest corner of Bunker Storage Facility. Located approximately 20 feet north of north edge of South Street, and approximately 100 feet west of centerline of railroad track, at north edge of South Street.

Elev. 742.45

TBM 30

SE 1/4 of SW 1/4 of SE 1/4 of SW 1/4 of Section 23, T7N, R2W - SCS nail and disk on south side of power pole located approximately 16 feet north of north edge of South Street. Located approximately 1740 feet east and approximately 30 feet north of southwest corner of Section 23.

Elev. 745.61

TBM 30a

Section 23, T7N, R2W - SCS nail and disk in south side of power pole located approximately 410 feet west of South Chestnut Street and 30 feet north of the centerline of South Street.

Elev. 742.98

TBM 31

SE 1/4 of SW 1/4 of SW 1/4 of SW 1/4 of SW 1/4 of Section 23, T7N, R2W - SCS nail and disk on north side of power pole located approximately 16 feet north of north edge of South Street, approximately 600 feet east and 30 feet north of southwest corner of Section 23.

Elev. 754.65

TBM 31a

Section 23, T7N, R2W - Outlet invert of 12 inch diameter concrete pipe at south end of detention pond, approximately 550 feet east of Delaney Road on the north ditch bank of Bock Branch.

Elev. 750.46

TBM 32

SW 1/4 of NW 1/4 of SW 1/4 of SW 1/4 of Section 23, T7N, R2W - SCS nail and disk on west side of power pole located approximately 35 feet east of the centerline of Delaney Road. Approximately 780 feet north of South Street, and approximately 150 feet north of Bock Branch.

Elev. 757.37

TBM 33

West side of NE 1/4 of NE 1/4 of Section 26, T7N, R2W - Center of manhole cover of sanitary sewer located approximately 1320 feet west and 195 feet south of northeast corner of Section 26. Located approximately 12 feet east of Owosso Drain ditch bank and approximately 22 feet south of fenceline of ditch bank.

Elev. 741.79

TBM 34

West side of NE 1/4 of NE 1/4 of Section 26, T7N, R2W - Top of bolt on west side of flange of sanitary sewer cover, located approximately 24 feet northwest of trailer at 1410 Calvert Street, and approximately 16 feet east of Owosso Drain ditch bank. Located approximately 1320 feet west and 680 feet south of northeast corner of Section 26.

Elev. 740.45

TBM 34a

West side of NE 1/4 of NE 1/4 of Section 26, T7N, R2W - Center of sanitary sewer manhole cover 1860z located northwest of trailer at 1410 Calvert Street and approximately 20 feet east of Owosso Drain ditch bank.

Elev. 741.04

TBM 35

W 1/16 section line of NE 1/4 of NE 1/4 of Section 26, T7N, R2W - Center of manhole cover approximately 22 feet west of trailer at 1412 Pembroke Street, and approximately 20 feet east of Owosso Drain ditch bank. Located approximately 1320 feet east and 1140 feet south of northeast corner of Section 26.

Elev. 740.06

TBM 36

West section line of NW 1/4 of SE 1/4 of NE 1/4 of Section 26, T7N, R2W - Top of bolt on northeast side of flange of manhole cover located southwest of 1419 Renfrew Street. Located 1320 feet west and 1540 feet south of northeast corner of Section 26. Located approximately 20 feet east of ditch bank and 35 feet north of cyclone fence along ditch bank south of trailer park.

Elev. 742.55

TBM 37

North section line of SE 1/4 of SW 1/4 of SW 1/4 of NE 1/4 of Section 26, T7N, R2W - Top of east corner of lowest cross beam of structure on upstream end of CMP arch, 6.5 feet wide, 5.2 feet high; at lane crossing ditch. Located approximately 1770 feet west and approximately 1990 feet south of northeast corner of Section 26.

Elev. 737.31

TBM 38

SW 1/4 of NW 1/4 of SE 1/4 of Section 26, T7N, R2W - SCS nail and disk in the west side of a 36 inch diameter maple tree located approximately 90 feet northeast of CMP culvert at farm crossing, and 40 feet east of Owosso Drain ditch bank. Located approximately 2310 feet west and approximately 1690 feet north of southeast corner of Section 26.

Elev. 743.96

TBM 39

SW 1/4 of SE 1/4 of SW 1/4 of Section 26, T7N, R2W - SCS nail and disk in the south side of an 18 inch diameter poplar tree on the southwest edge of a pond, approximately 70 feet east of centerline of the culvert in the ditch crossing. Located approximately 1640 feet east and 350 feet north of the southwest corner of Section 26.

Elev. 741.67

TBM 40

Southeast corner of SW 1/4 of SW 1/4 of Section 26, T7N, R2W - SCS nail and disk in the east side of a 10 inch diameter tree on a property line west of the ditch at the culvert under Dewey Road and 29 feet north of the centerline of Dewey Road. Located approximately 1320 feet east of the southwest corner of Section 26.

Elev. 741.07

TBM 40a

Section 35, T7N, R2W - SCS nail and disk in southeast fence corner post, located approximately 440 feet south of Dewey Road and approximately 700 feet east of Delaney Road.

Elev. 741.39

TBM 41

Section 26, T7N, R2W - SCS nail and disk in south side of power pole located approximately 6 feet north of north side of Dewey Road and 125 feet east of centerline of Delaney Road.

Elev. 746.90

TBM 42

SW 1/4 of SE 1/4 of NE 1/4 of Section 34, T7N, R2W - SCS nail and disk in south side of 12 inch diameter maple tree, along old fenceline, approximately 50 feet east of railroad grade. Located approximately 450 feet north of property line (path intersection) along railroad grade, and approximately 2400 feet southwest of northeast corner of Section 34, along railroad grade.

Elev. 743.36

APPENDIX F

GLOSSARY

BACKWATER - The resulting high water surface upstream from a dam, bridge or other obstruction in a river channel or high stages in a receiving stream.

BRIDGE DECK - Elevation of road surface at the bridge.

BRIDGE LOW CLEARANCE - The lowest point of a bridge or other structure over or across a river, stream or water course that limits the opening through which water flows. This is referred to as "low steel" or "low chord". It often is higher than the low point of the roadway.

CHANNEL or WATER COURSE - An elongated depression either natural or man-made having a bed and well-defined banks varying in depth, width and length which gives direction to a current of water and is normally described as a creek, stream or riverbed.

CHANNEL BOTTOM - The lowest part of the stream channel (either in a constructed cross-section or a natural channel). Bottom elevations at a series of points along the length of a stream may be plotted and connected to provide a stream bottom profile.

CONFLUENCE - A flowing together or place of junction of two or more streams.

CROSS-SECTION or VALLEY SECTION - A graph showing the shape of the stream bed, banks and adjacent land on either side made by plotting elevations at measured distances along a line perpendicular to the flow of the stream.

DATUM - An assumed reference plane from which elevations and depths are measured such as from sea level.

ELEVATION-DISCHARGE RELATIONSHIP - The relationship between water surface elevation and rate of flow at a specified location for a range of flow rates.

FLOOD - A temporary overflow by a river, stream, ocean, lake or other body of land not normally covered by water. It does not include the ponding of surface water due to inadequate drainage such as within a development. It is characterized by damaging inundation, backwater effects of surcharging sewers and local drainage channels, and by unsanitary conditions within adjoining flooded habitated areas attributable to pollutants, debris and water table.

FLOOD CREST - The maximum stage or elevation reached by flood waters at a given location.

FLOOD FREQUENCY - A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equaled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequence", but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years.

10-YEAR FLOOD - A flood having a long-term average frequency of occurrence in the order of once in 10 years. It has a ten percent chance of being equaled or exceeded in any given year.

100-YEAR FLOOD - A flood having a long-term average frequency of occurrence in the order of once in 100 years. It has a one percent chance of being equaled or exceeded in any given year. This flood is comparable to the "Intermediate Regional Flood" used by the U.S. Army Corps of Engineers.

FLOOD PEAK - The maximum instantaneous discharge or volume of flow in cubic feet per second passing a given location. It usually occurs at or near the time of the flood crest.

FLOOD PLAIN - The relatively flat area or low lands covered by flood waters originating with either the adjoining channel of a water course such as a river or stream, or a body of standing water such as an ocean or lake.

FLOOD PRONE AREA - Areas that experience ponding due to high water table soils and/or inadequate outlets.

FLOOD ROUTING - The process of determining progressively the timing and shape of a flood wave at successive points along a stream. This procedure is used to derive a downstream hydrograph from an upstream hydrograph. Local inflow and tributary hydrographs are considered.

FLOOD STAGE - The elevation at which overflow of the natural streambanks or body of water occurs.

FLOODWAY - The portion of the flood plain including the channel of the stream that is required for the conveyance of flood flow.

FLOODWAY FRINGE - The area of the flood plain lying outside the floodway which may be covered by flood waters originating from an adjoining river or stream.

HEAD LOSS - The effect of obstructions, such as narrow bridge openings, dams or buildings, that limit the area through which water must flow, raising the surface water upstream from the obstruction.

HEADWATER - The tributaries and upper reaches which are the sources of the stream.

HIGH WATER or FLOOD PROFILE - A graph showing the relationship of water surface elevation location along the stream. While it is drawn to show surface elevations for the crest of a specific flood, it may be prepared for conditions at any other given time or stage.

HYDRAULICS - The science of the laws governing the motion of water and their practical applications.

HYDROGRAPH - A graph denoting the discharge or stage of flow over a period of time.

HYDROLOGY - The science dealing with the occurrence and movement of water upon and beneath the land areas of the earth.

INUNDATION - The flooding or overflow of an area with water.

LEFT BANK - The bank of the left side of a river, stream or water course, looking downstream.

LOW GROUND - The highest elevation at a specific stream channel cross-section at which the flow in the stream can be contained in the channel without overflowing into adjacent overbank areas.

MANNING'S "n" - A coefficient of channel and overbank roughness used in Manning's open channel flow formula, commonly called a retardance factor.

REACH LENGTH - A longitudinal length of stream channel selected for use in hydraulic or other computations.

RIGHT BANK - The bank on the right side of the river, stream or water course, looking downstream.

ROAD OVERFLOW - The lowest elevation on a road profile in the vicinity of where the road and stream cross. It is the first point on the roadway inundated if overtopping of the road occurs during a storm.

RUNOFF - That part of precipitation, as well as any other flow contributions, which appears in surface streams of either perennial or intermittent form.

TIME OF CONCENTRATION - Time required for water to flow from the most remote point of a watershed to the outlet or other point of reference.

WATERSHED - A drainage basin or area which collects runoff and transmits it, usually by means of streams and tributaries, to the outlet of the basin.

WATERSHED BOUNDARY - The divide separating one drainage basin from another.

APPENDIX G

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